Generics Are a Cognitive Default: Evidence From Sentence Processing

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Abstract

We tested the hypothesis that generics (e.g., *Dogs* have four legs) are a cognitive default, thereby allowing faster and less effortful processing in comparison to quantified noun phrases (e.g., *all dogs)*. Participants judged sentences containing either generics or universally-quantified noun phrases as true or false. Under time pressure, participants treated universally-quantified noun phrases as if they were generics (e.g., responding *true* to *All dogs have four legs*, despite the existence of three-legged dogs). Participants also took longer to respond to sentences with universal quantifiers vs. generics. Data thus support a generics-as-default account.

Keywords: generics; quantifiers; concepts; sentence processing.

Introduction

Generic noun phrases, or generics (e.g., *Giraffes* have long necks) refer to kinds rather than specific individuals (e.g., *Those giraffes* have long necks). Due to their unique semantic and conceptual attributes, generics have attracted attention in fields as diverse as philosophy, linguistics, and psychology (Gelman, 2003; Leslie, 2008; Pelletier, 2010). Still, little is known about how generics are represented and accessed cognitively. In the current study, we examined one contemporary proposal that to date has received little direct empirical support, namely the idea that generics are a cognitive default (though see Leslie, 2008, for a theoretical and philosophical treatment).

In broad form, the generics-as-default proposal holds that the referents of generics are early-acquired and easily accessible, and therefore that generics present few cognitive processing demands to speakers. Additionally, the proposal holds that processing quantified sets (e.g., *all* Xs, *most* Xs) requires more effort and draws on more sophisticated and later-developing mechanisms.

An important assumption of the generics-as-default account is the claim that generics are fundamentally distinct from noun phrases marked by explicit quantifiers such as *all* or *most*. Note the contrast, for instance, between *Dogs have four legs* and *All dogs have four legs*. Whereas only one three-legged dog is needed to falsify the claim that four-leggedness applies to *all* dogs, generics allow for counterexamples; despite the occasional three-legged dog you may have encountered, the statement *Dogs have four legs* remains acceptable. Further, while one might recast the sentence *Dogs have four legs* as *Most dogs have four legs*, sets quantified by *most* similarly do not equate to the referents of generics. Consider, for instance, that although *Sharks attack swimmers* is often judged as acceptable, *Most sharks attack swimmers* is not. Generics are thus not reducible to quantifiers conveying statistical prevalence (e.g., Cimpian, Gelman, & Brandone, 2010).

Noting these sorts of distinctions, most semantic analyses impute qualitative differences between generic and quantified reference (Carlson, 2010; Leslie, 2008) and reject earlier quantificational analyses treating generics as if they contained implicit quantification (e.g., Clark, 1973). Generics instead are *kind-referring* (Carlson, 2010), and as such, they allow speakers to discuss entirely abstract concepts rather than sets of individuals. That is, kinds have no direct real-world instantiation, but rather are mental representations, and generics are the linguistic means of referring directly to these representations.

Support for the Generics-as-Default Position

Recognizing the fundamental distinction between generics and quantified sets, the generics-as-default position further characterizes generics as referring to *cognitively basic* kind-based representations. The proposal draws empirical support from a number of observations. First, generics are ubiquitous; they have been found in every human language that has been studied (e.g., Gelman & Tardif, 1998; Goldin-Meadow, Gelman, & Mylander, 2005). However, there is no explicit word or morpheme in *any* language that unambiguously expresses genericity (e.g., Carlson, 2010; Leslie, 2008); instead, generics are typically signaled by a *lack* of marking, a pattern consistent with how default or stereotypical concepts are expressed in language (e.g., Levinson, 2000).

Second, despite the impoverished marking of generics, they are acquired early in development. Corpus-based studies of English-speaking children, for example, suggest that children start to produce generics at about age 2½ years (Gelman et al., 1998), at about the same time they acquire relevant linguistic markings needed to express these forms and distinguish them from particular and/or quantified forms (e.g., nouns modified by determiners or quantifiers) (Gelman, 2004). As well, young children often have difficulty in comprehending quantifiers such as *all* and *some*, and make errors suggesting that at first they interpret quantified reference as generic, only later acquiring comprehension of the quantifier. For instance, when three-year-old children were asked whether properties (e.g., *being hot*) were true of all members of a set (e.g., *all fires*), some members of a set (*some fires)*, or of the generic kind *(fires)*, they tended not to differentiate among the three forms, instead responding with patterns similar to those observed within four-year-old children's and adults' responses to those items featuring generic forms (Hollander, Gelman, & Star, 2002).

The observations outlined above are consistent with a generics-as-default account. However, it is only recently that the generics-as-default position has been put to the test in empirical psycholinguistic studies. In one recent study, Leslie and Gelman (2011) demonstrated that for both preschool-aged children and adults, quantified statements were more often misremembered as statements about generics than vice versa. For instance, after learning *All cats sweat through their paws*, both child and adult participants were likely to report having heard *Cats sweat through their paws* after a short (four-minute) delay. The reverse error, however, was rarely observed, suggesting that generic representations are robust in memory and resilient against distortion.

Overview of the Current Study

The current study focuses on real-time processing of sentences containing generic and quantified noun phrases. This approach has the advantage of testing predictions regarding *on-line* comprehension of generics derived from the generics-as-default position, and to our knowledge is the first study to directly examine this type of processing.

The basic logic behind the current study is this: If generics are default, it should be easier to judge that a property is characteristic of a generic kind (e.g., *dogs*) than of a quantified set (e.g., *all dogs*). We expected this generic advantage to be especially apparent when participants were asked to make their judgments under time pressure. That is, when speeded, we expected participants to have the most difficulty in processing quantified sets, reflected by participants' treating quantified statements *as if* they contained generics--in other words, answering based on the more accessible representation (the generic kind). For instance, when judging the sentence *All dogs have four legs*, we expected speeded participants to be more likely to default to a judgment about the generic *dogs,* and thus respond that this sentence is true. We also predicted that response times would reflect the effort required to process a generic vs. a quantified noun phrase; that is, the time participants took to judge *All dogs have four legs* would be longer than the time required to judge *Dogs have four legs.* (To eliminate the problem of universally-quantified sentences always being longer in length, and thus predicted to require more time to process, noun phrases were always presented first in isolation, followed by the predicate in isolation.)

Our main comparison of interest was thus between processing of sentences that we expected would be judged true in generic form (e.g., *Dogs have four legs*) and false in universally-quantified form (e.g., *All dogs have four legs*). We called these sentences *wide-scope*, since, for instance, most but not all dogs have four legs. We also included sentences of two other types of scope. First, we asked participants to judge *full-scope* sentences, i.e., sentences for which the predicate would likely be judged true of all instances as well as the generic kind (e.g., *All giraffes/Giraffes have long necks*). These sentences were included for two reasons. First, they required participants to sometimes respond *true* for universally-quantified sentences, minimizing the concern that participants would simply learn a rule that universally-quantified sentences were *always* false in this experiment. Second, we also had theoretically-motivated predictions regarding participants' accuracy and response time for these items. Namely, although we did not predict differences in *accuracy* between responses to generic and universally-quantified sentences (since if participants defaulted to a generic reading, they should still respond *true* to a universally-quantified sentence), we did predict differences in response time. Specifically, we predicted that verifying a generic full-scope sentence would take less time than verifying a universally-quantified full-scope sentence, since default generic representations should be more easily and quickly accessed than quantified sets.

Finally, we also included irrelevant-scope sentences, i.e., sentences that we expected would be judged false in *both* universally-quantified and generic form, e.g., *All squirrels/ Squirrels have beaks*. Including irrelevant-scope sentences also served two separate purposes. First, it required responses of *false* to sentences containing generics, minimizing the concern that participants would simply learn a rule that generic sentences were always true in this experiment. Second, these items provided us a baseline measure of how much time was required to falsify a sentence in our experiment. Recall that one of our main predictions was that falsifying a universally-quantified wide-scope sentence (e.g., *All dogs have four legs*) would take longer than verifying a generic wide-scope sentence (e.g., *Dogs have four legs*). Since language processing studies consistently demonstrate a time advantage for verification over falsification (e.g., Carpenter & Just, 1975), simply demonstrating longer processing for *All dogs have four legs* could be explained by this basic verification advantage rather than faster access to generic representations. However, if participants were slower to falsify *All dogs have four legs* over and above the time it took to falsify irrelevant-scope sentences, this would suggest that the increase in time was due to some other processing demand aside from that required by mere falsification. (See Table 1 for sample sentences.)

Table 1: Sample Sentences by Scope and Form

Scope	Sentence* in Universally Quantified Form	Predicted Response**	Sentence* in Generic Form	Predicted Response**
Irrelevant	All squirrels have beaks	FALSE	Squirrels have beaks	FALSE
Full	All giraffes have long necks	TRUE	Giraffes have long necks	TRUE
Wide	All dogs have four legs	FALSE	Dogs have four legs	TRUE

* Subject noun phrases were presented in isolation, followed by predicates. Participants responded once the predicate appeared.

** Participants' responses that matched predicted responses were considered accurate; responses that mismatched predicted responses were considered inaccurate.

Method

Participants

Thirty-three undergraduate students (19 female) participated. Data from one individual were excluded because average response time was more than 2.5 SDs above the group mean, leaving a final total sample of 32.

Materials

Participants judged a main set of 44 sentences (Set 1) as true or false. Each sentence contained a noun phrase and a predicate. Universally-quantified vs. generic noun form was within-subjects, i.e., within the set, half the sentences referred to universally-quantified referents (i.e., all + noun + -*s*), while the other half referred to generic categories (i.e., noun + -*s*). Universally-quantified and generic forms were grouped in two separate blocks. We also created three practice sentences that did *not* refer to either a generic or a quantified set. Participants responded to these sentences before the main set to acquaint themselves with the task.

We created three additional versions of the main set for counterbalancing purposes. Specifically, for each noun, Set 2 used the noun form that was different from Set 1 (e.g., Set 1 used the generic *dogs*, whereas Set 2 used the universally-quantified *all dogs*). Thus, across subjects, every noun appeared in both generic and universally-quantified form an equal number of times. Sets 3 and 4 reversed block order of presentation from Sets 1 and 2, such that half the participants responded to the generic block first, and the other half to the universally-quantified block first.

In addition to varying in noun form (universally-quantified vs. generic), sentences also varied along scope. As described above, we expected participants to falsify irrelevant-scope sentences in both universally-quantified and generic form, and to verify full-scope sentences in both universally-quantified and generic form. Finally, we predicted that wide-scope sentences would be judged false in universally-quantified form but true in generic form. Each participant responded to 12 irrelevant-scope, 16 full-scope, and 16 wide-scope sentences, and there were equal numbers of universally-quantified and generic forms within each scope type.

Procedure

Sentences were presented on E-Prime v. 2.0.8.22. For each sentence, the noun phrase appeared in the center of the screen in isolation for 2000 ms.. Immediately after, the predicate appeared in isolation. (Noun phrase and predicate were presented separately so as to avoid a systematic increase in response time for the sentences containing the universally-quantified forms, as these included one additional word relative to the generic forms [*all*].)

Participants judged whether each sentence created by a given noun phrase and its predicate was true or false by pressing the appropriate key. Half the participants were instructed to answer as quickly as possible (speeded condition), whereas the other half of participants were told that they could take as long as they wanted (unspeeded condition). Response key locations for true and false were counterbalanced across participants. Participants were not given feedback for either correct or incorrect answers; every response was simply followed by a 1000 ms blank screen and then the next trial.

Results

Accuracy Analysis

We performed a mixed between-within 2 (speed condition: speeded vs. unspeeded) x 2 (noun form: universally-quantified vs. generic) x 3 (scope: irrelevant vs. full vs. wide) ANOVA on accuracy (i.e., degree to which responses matched the predicted true vs. false responses), with speed condition as the between-subjects variable, and noun form and scope as within-subjects variables.

The ANOVA yielded main effects for speed condition ($F(1, 30) = 4.11$, $p = .05$), noun form ($F(1, 30) = 31.12$, $p < .001$), and scope ($F(1.51, 45.28) = 39.19$, $p < .001$). These main effects were qualified by two two-way interactions: Noun form x speed condition ($F(1, 30) = 8.94$, $p = .006$) and noun form x scope ($F(1.31, 39.38) = 10.53$, $p = .001$).

These interactions were further qualified by the predicted three-way speed condition x noun form x scope interaction ($F(1.31, 39.38) = 8.10$, $p = .004$, $\eta_p^2 = .27$). No additional significant main effects or interactions were observed. (Greenhouse-Geisser corrected statistics are reported due to violations in sphericity.)

To further explore the nature of the three-way interaction, we used Bonferroni-corrected paired *t*-tests to compare accuracy on universally-quantified vs. generic form sentences within scope and speeded vs. unspeeded conditions. The only significant difference was, as predicted, in the speeded wide-scope condition, with accuracy higher for sentences containing generics (M = 89.84%, SD = 11.38) than for sentences containing the universal quantifier *all* (M = 55.47%, SD = 25.40), t (15) = 5.97, $p < .001$, Cohen's d = 1.74 (Figure 1).

Response Time Analysis

We analyzed response times for correct responses. Response times that were outside 2.5 standard deviations of an individual's mean time were removed. Due to positive skew, we log-tranformed the data. Analyses were conducted on these transformed data, but raw means (in milliseconds) are provided for ease of interpretation. For comparisons involving response times to wide-scope sentences, data from one individual were excluded due to all responses within this condition being either incorrect or being outliers (resulting in no data for that cell).

We used a mixed-between 2 (speed condition: speeded vs. unspeeded) x 2 (noun form: universally-quantified vs. generic) x 3 (scope: irrelevant vs. full vs. wide) ANOVA to examine response times. Main effects were observed for speed condition (F (1, 29) = 56.84, $p < .001$), noun form (F (1, 29) = 35.13, $p < .001$), and scope (F (2, 58) = 15.73, $p < .001$). These main effects were qualified by two two-way interactions: Noun form x scope (F (1.58, 45.9) = 12.31, $p < .001$) and scope x speed condition (F (1.88, 54.50) = 8.45, $p = .001$). Finally, these in turn were qualified by the predicted three-way speed condition x noun form x scope interaction, F (1.58, 45.89) = 7.17, $p = .004$, $\eta_p^2 = .26$). (Greenhouse-Geisser corrected statistics are reported due to violations in sphericity.)

We explored this three-way interaction using Bonferroni-corrected paired *t*-tests, comparing response times to sentences containing universally-quantified vs. generic forms within each scope and speed condition. No differences were observed for sentences with irrelevant scope (*p*s > .05). For full-scope sentences, participants were faster to respond to sentences containing generic vs. universally-quantified forms in both speeded ($M_{generic}$ = 931.32 ms, SD = 253.93 vs. $M_{universally\text{-}quantified}$ = 1057.06 ms, SD = 219.94; t (15) = 5.01, $p < .001$, Cohen's d = 1.35) and unspeeded conditions ($M_{generic}$ = 1427.91 ms, SD = 208.52; $M_{universally\text{-}quantified}$ = 1842.39 ms, SD = 572.54; t (15) = 5.50, $p < .001$, Cohen's d = 2.78). Finally, for wide-scope sentences, there were no differences in response times for generic vs. universally-quantified sentences in the unspeeded condition ($p > .05$), but when speeded, participants were faster to respond to generic sentences (M = 900.05 ms, SD = 204.03) vs. universally-quantified sentences (M = 1065.71 ms, SD = 180.57, t (14) = 4.62, $p < .001$, Cohen's d = 1.11) (Figure 2).

A final Bonferroni-corrected paired *t*-test compared response times for universally-quantified speeded wide- vs. irrelevant-scope sentences. This was done to establish that the difference between the speeded generic and universally-quantified wide-scope sentences described above was not attributable merely to the demands required by "mere falsification". As expected, the time speeded participants took to falsify irrelevant-scope universally-quantified sentences (M = 950.64 ms, SD = 158.51) was less than the time to falsify wide-scope universally-quantified sentences (M = 1065.71 ms, SD = 180.57), t (14) = 3.07, p = .008.

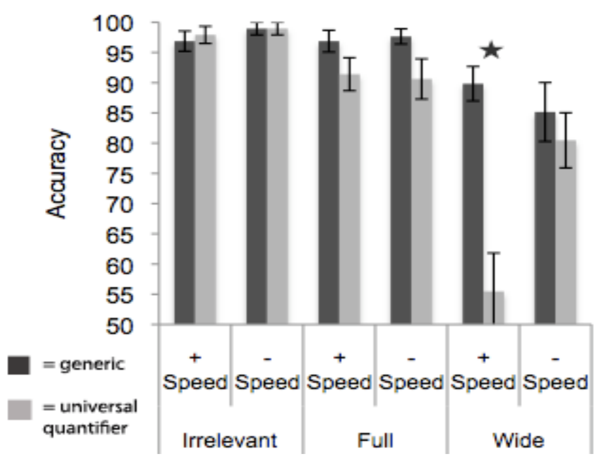

Figure 1: Accuracy (%) within scope, speed, and noun form condition

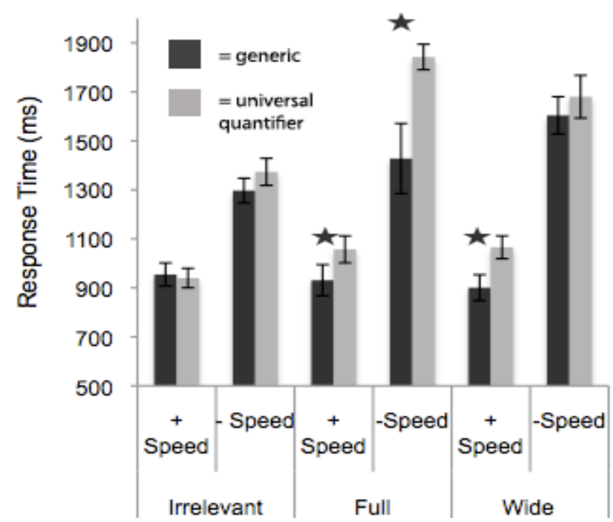

Figure 2: Correct response times (ms) within scope, speed, and noun form condition

Discussion

Summary

Results from both accuracy and response time analyses were consistent with our predictions, supporting a generics-as-default account. Specifically, speeded participants were more likely to treat universally-quantified noun phrases as if they were generics, reflected by decreased accuracy in processing wide-scope sentences containing universal quantifiers (e.g., *All dogs have four legs*). That is, when asked to report whether a sentence that acceptably characterizes a generic kind but does not hold true for *all* members of a kind, participants were likely to make judgments consistent with their knowledge of generics, for example responding *true* to *All dogs have four legs*. The fact that this decrement in accuracy was absent in the non-speeded condition further argues in favor of a generics-as-default argument, as the spared performance in that condition establishes that participants are capable of interpreting the universally-quantified sentences appropriately (i.e., recognizing the existence of counterexamples that falsify the sentences), just so long as they are not pressured to respond quickly.

Response times were also consistent with the generics-as-default position. In cases when speeded participants falsified universally-quantified wide-scope sentences (e.g., saying *false* to *All dogs have four legs*), it took longer than verifying the generic equivalent (i.e., saying *true* to *Dogs have four legs*); further, this falsification also required time above and beyond that required for "mere falsification" (i.e., falsifying irrelevant-scope universally-quantified sentences, e.g., *All squirrels have beaks*). Finally, participants also took longer to verify universally-quantified full-scope sentences (e.g., *All giraffes have long necks)* vs. the generic alternative (*Giraffes have long necks),* despite the ultimate response of *true* being identical for both types of sentences, and despite noun phrases being presented separately from predicates to eliminate the confound of universally-quantified noun phrases being longer in length. The fact that the difference was observed not just in the predicted speeded condition, but also in the unspeeded condition, is entirely consistent with a generics-as-default account. We speculate that even when unspeeded, participants were likely hesitant to endorse the veracity of the universally-quantified sentences because they were trying to think of plausible counterexamples (although they eventually did tend to respond *true*, as predicted), whereas they were relatively fast to respond to the generic version based on their default generic representations.

Future Directions

Several outstanding questions still remain that create opportunities for future research. Most importantly, the current study was restricted to comparisons between generics and universally-quantified noun phrases; however, to demonstrate that generics are a cognitive default, it will be important in the future to examine the processing of other quantifiers relative to generics. For instance, recall the comparison between the sentences *Most sharks attack swimmers* and *Sharks attack swimmers* described earlier. The latter sentence has been proposed as a subtype of generic reference, in which dangerous and highly salient properties may be acceptably predicated of a generic kind, even if that property is true of only a minority of instances (e.g., Khemlani, Leslie, & Glucksberg, 2009; Leslie, 2008). Here again, we would also expect that responding to a predicate that follows a most-quantified noun phrase would take longer than responding to the same predicate following a generic noun phrase. A study including such items is currently underway. One intriguing possibility is that participants' verification time for these "rare-but-dangerous" generics will be even faster than for the wide- and full-scope generics featured in the current study, suggesting robust connections between salient dangerous qualities and the kinds that possess them.

It will also be instructive to research distinctions between generics and non-quantified reference such as definite reference (e.g., *the dogs*). A small amount of neurophysiological work supports the idea that there are qualitative distinctions between generics and this type of noun phrase, making further investigations into underlying cognitive mechanisms an inviting possibility. Namely, Prasada and colleagues have conducted ERP studies comparing processing for sentences containing generic kind-referring terms (e.g., *Grass is green*) vs. sentences containing definite reference (e.g., *The grass is green*). In this study, the authors found larger N400 responses to kind-referring generics. Although the precise reason for the differences could not be established in the study, the authors speculate that a generic's reference to concepts within semantic memory likely recruits different processes for understanding (as opposed to the referents of definite noun phrases, which depend on discourse and contextual considerations for comprehension) (Prasada et al., 2008).

Finally, it will also be useful to extend the current study to a developmental population. Given that generics appear to be acquired early relative to comprehension of quantifiers, and further that preschool-aged children's errors in comprehending quantifiers suggest an early bias toward generic representation (e.g., Hollander, Gelman, & Star, 2002), it stands to reason that children might also display some of the same processing styles observed in adults in the current study. One possibility regarding the developmental trajectory on our task is that children will start out making errors consistent with a generic default bias in both speeded and unspeeded conditions, with errors in comprehending quantifiers showing a decrease across development in the unspeeded condition (that is, more closely approximating the pattern displayed by adults). Adapting the current methodology to one more suitable for children will be an important future pursuit (e.g., having sentences presented out loud rather than appearing on a screen, providing children with button boxes for their responses, using simpler items, etc.).

The cognitive underpinnings of generics remain a fascinating topic for future studies. In the current paper, we demonstrated that people are more easily able to access generic representations in comparison to universally-quantified sets, suggesting that generics exist as a cognitive default. We thus provide some of the first direct psycholinguistic evidence in support of a generics-as-default position, underscoring the importance of further examining the interface between language and kind-based representations.

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